Spray Plume Movement as a Function of Atmospheric Stability

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Effects of Atmospheric Stability

- Yates et al. (1966)
  - Over 3 times deposition under very stable versus unstable
- Yates et al. (1967)
  - Wind speed dominates in near field
- MacCollom et al. (1986)
  - Greater drift distance and amounts under temperature inversions
- Hoffman and Salyani (1996)
  - Higher depositions for nighttime versus daytime applications

Effects of Atmospheric Stability

- Bird (1995)
  - Highest drift under relatively high wind speeds coupled with temperature inversions and small droplet spectra
- Miller et al. (2000)
  - Atmospheric stability dominates in far field
  - Increased wind speed and stable conditions important factors in higher drift amounts
  - 2 – 6 times the amount of drift under stable conditions versus unstable conditions

Objectives

- Field studies to assess spray drift and deposition under varying atmospheric conditions.
- Use of in-flight instrumentation to measure meteorological parameters and atmospheric stability

Field Study – Preliminary Results

Treatment

- VERY FINE Spray - $D_{V0.5}$ of 176 µm
  - CP-03 at 90° deflection, 0.125” orifice, 40 psi, 150 mph
- 5 gal/acre rate
- 6 foot spray height
- 50 ft swath width
- Spray solution - Trition X-100 at 0.1% v/v, and Caracid Brilliant Flavine FFN fluorescent dye at 17 g/acre

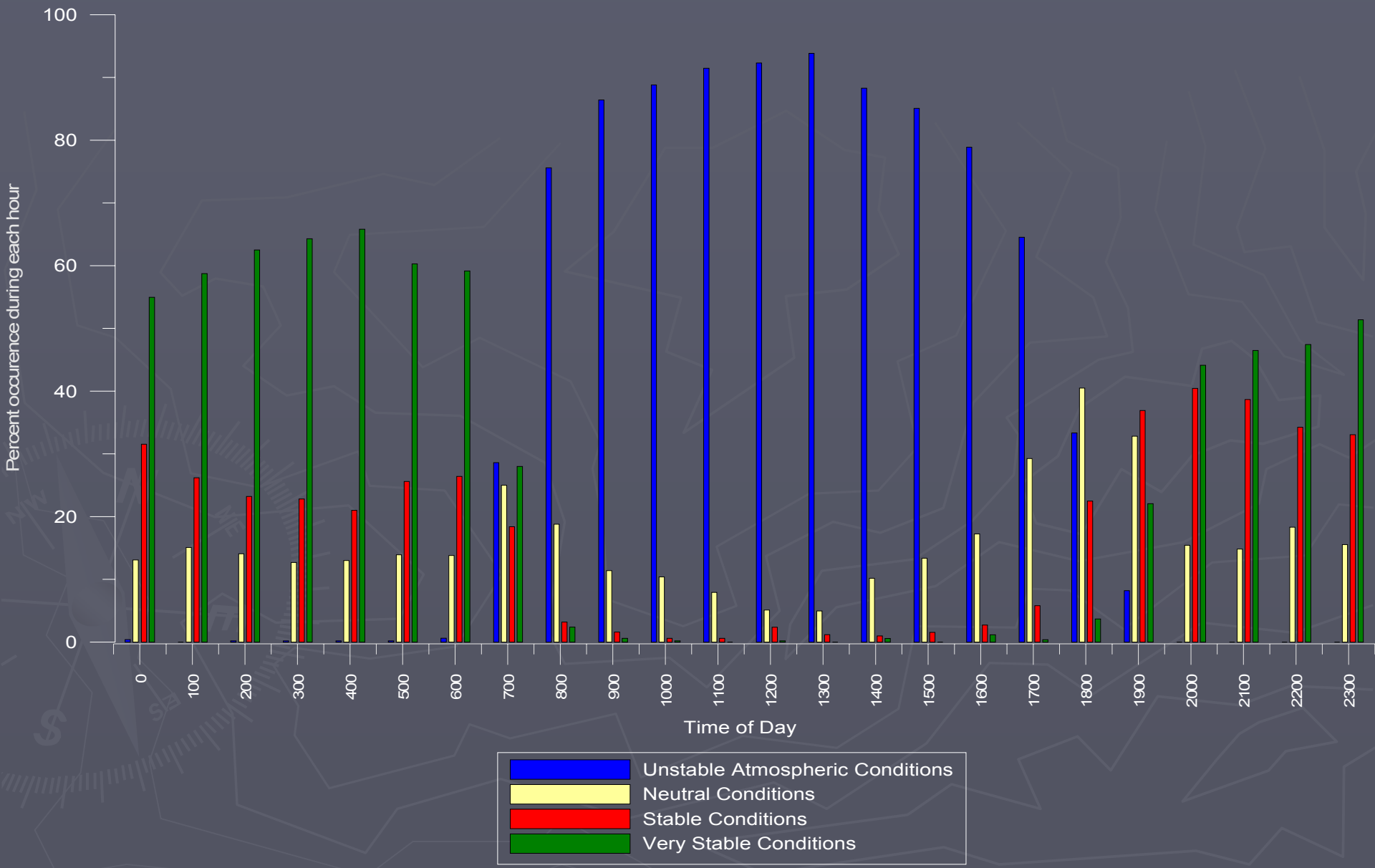
Sampling

- Mylar cards (-15 m to 50 m from swath edge)
- Elevated nylon screen (at 5’, 10’, 15’, 20’ at multiple downwind distances)

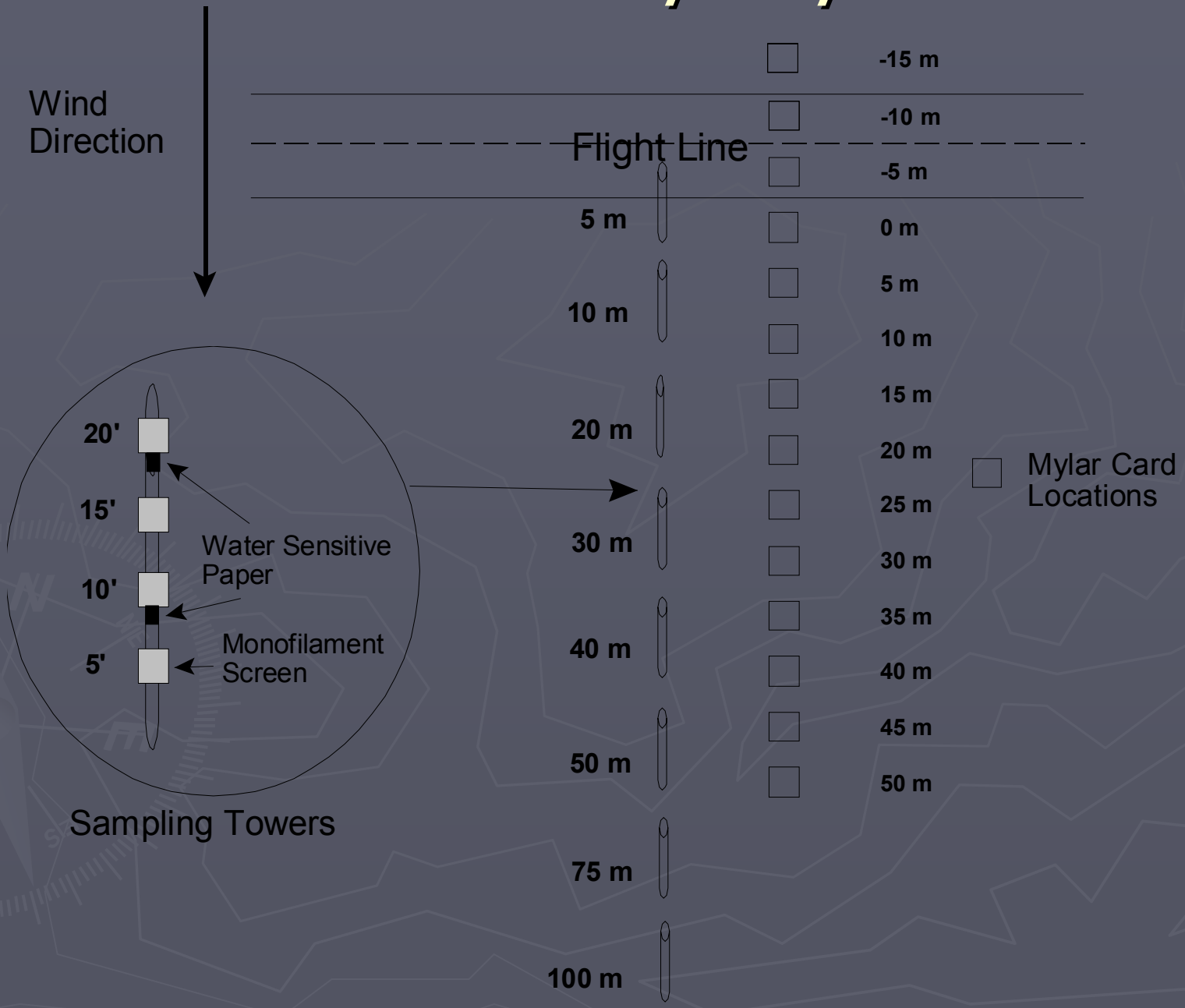
Spray Time

- Late afternoon – approx. 2 hours before dark

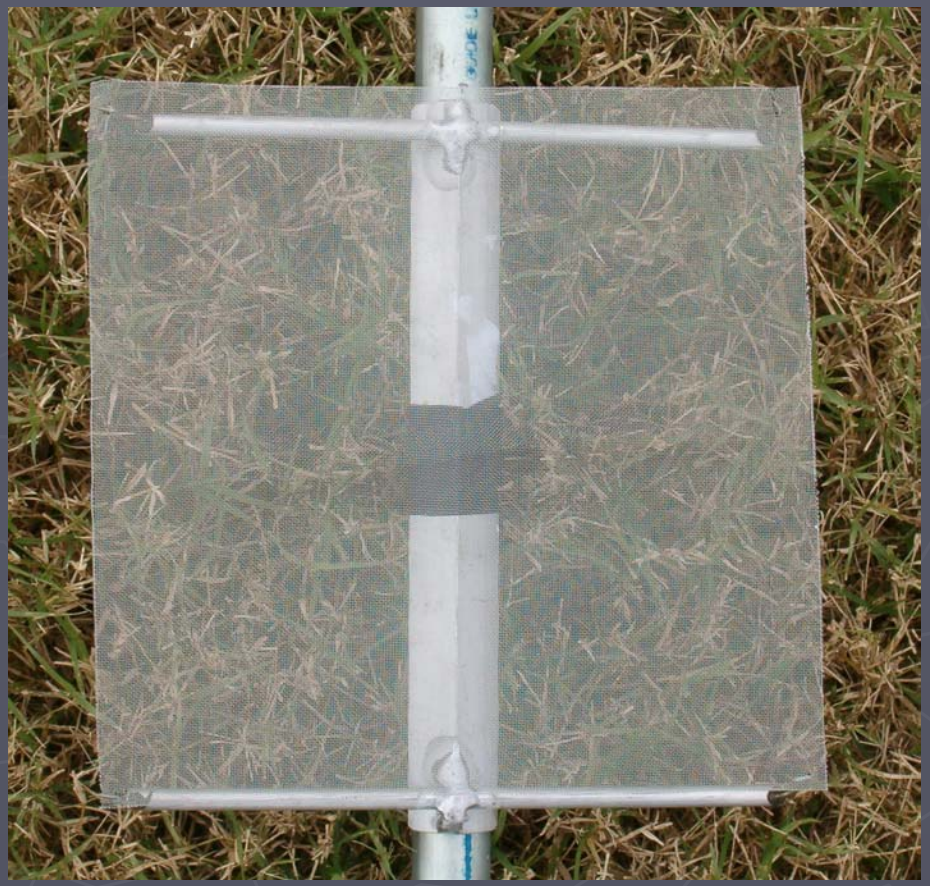
Distribution of Stability Conditions by Time of Day



Field Study Layout



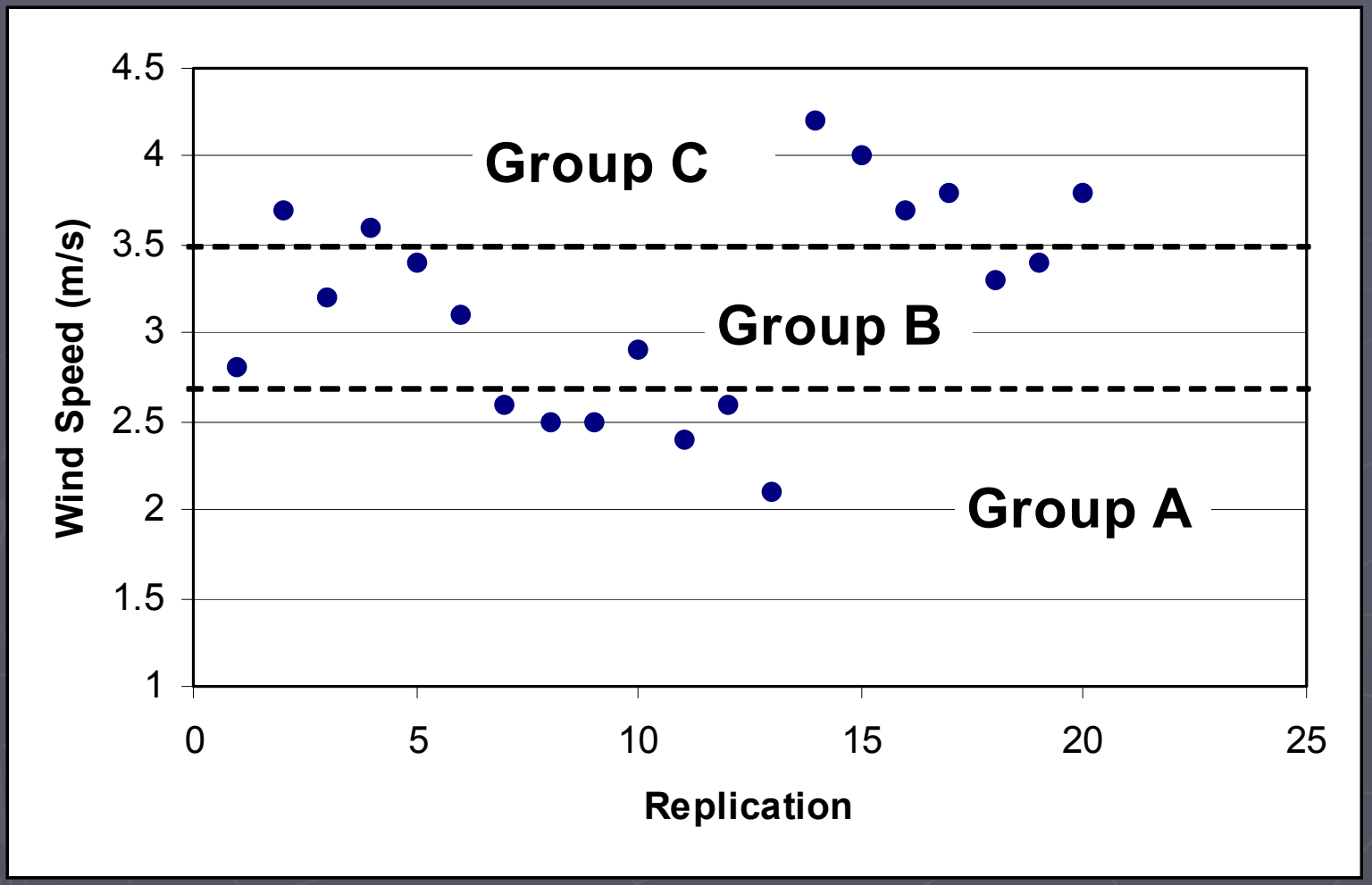
Screen Towers



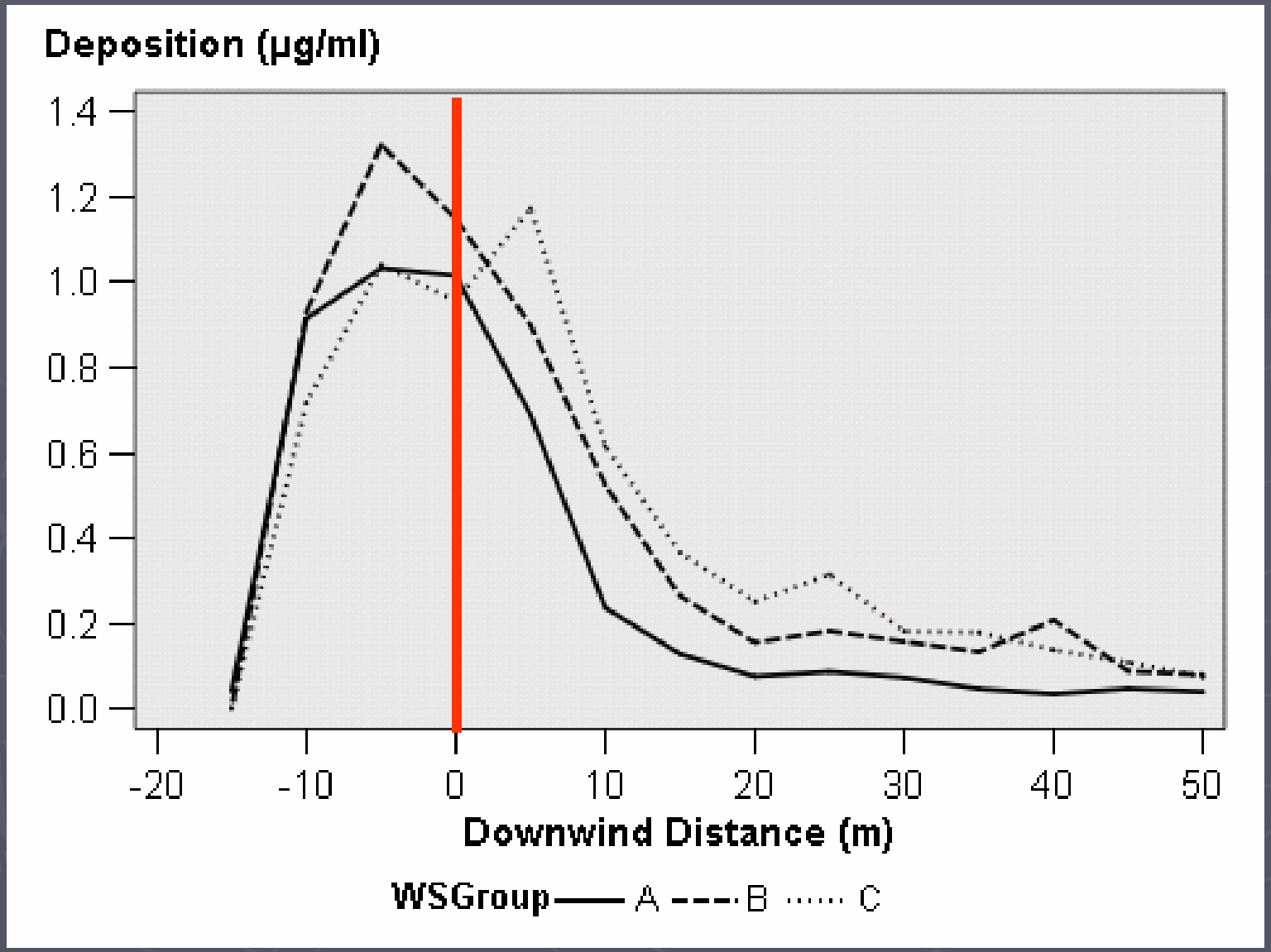
Meteorological Data

- Monitoring tower and 3-D anemometer used
  - Measured
    - Temperature and RH (4 heights)
    - Wind speed and direction (4 heights)
  - Calculated data
    - Averages and standard deviations
    - Stability metrics (SR, Ri, Classes)
- All data sets were grouped based on wind speed during spray run.
  - Initial statistical analysis did not indicate that other meteorological parameters had any significant effect (including stability effects)
    - Potential difficulty with temperature profile data
      - Stability steadily decreased as afternoon progressed for all 3 days
        - Not what would be expected
      - Tower near interface of two dissimilar surfaces (concrete runway and grassed field)
  - Wind speed was significant
    - Three wind speed groupings were created
      - Group effect was also significant

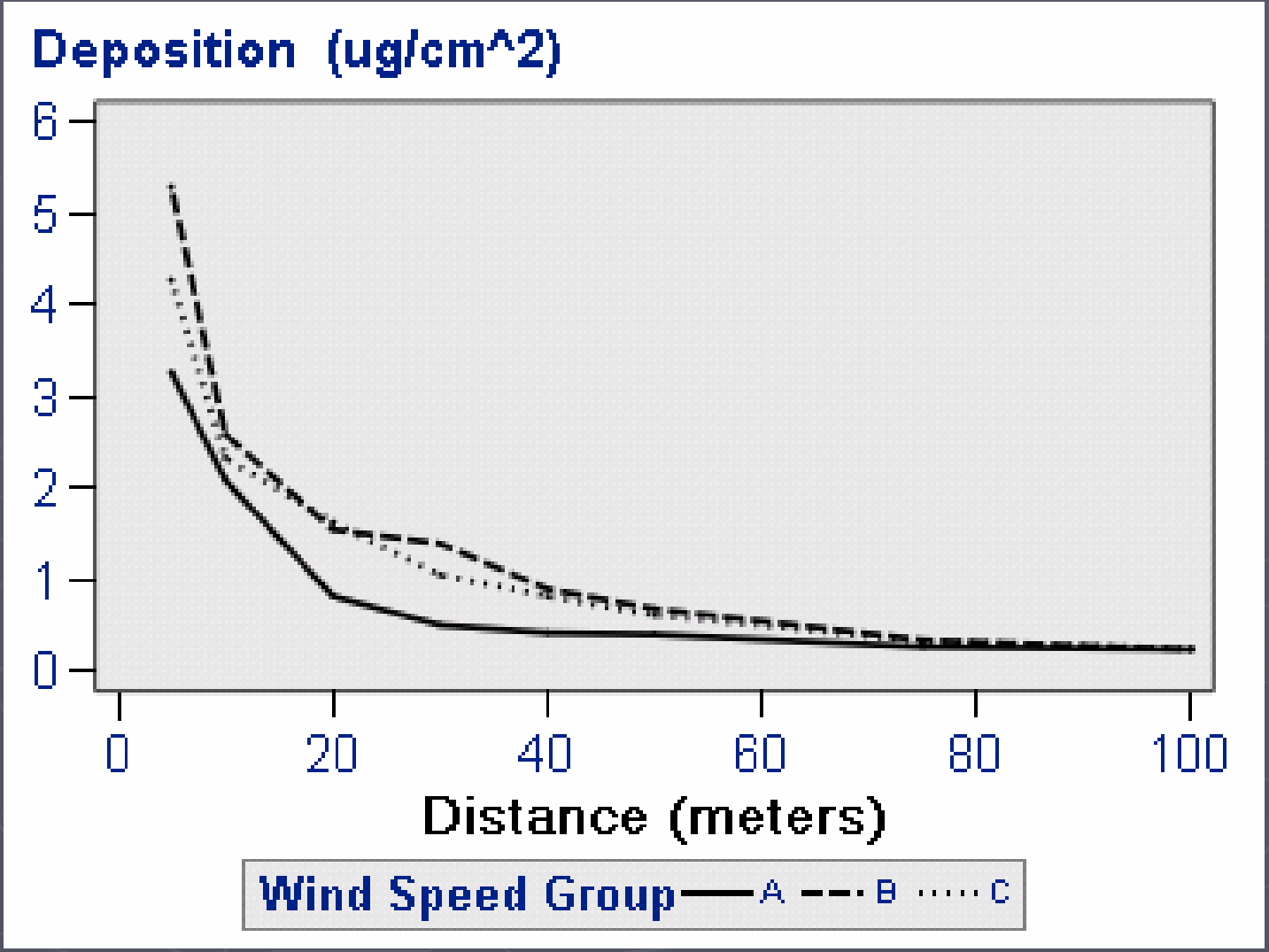
Wind Speed Groupings



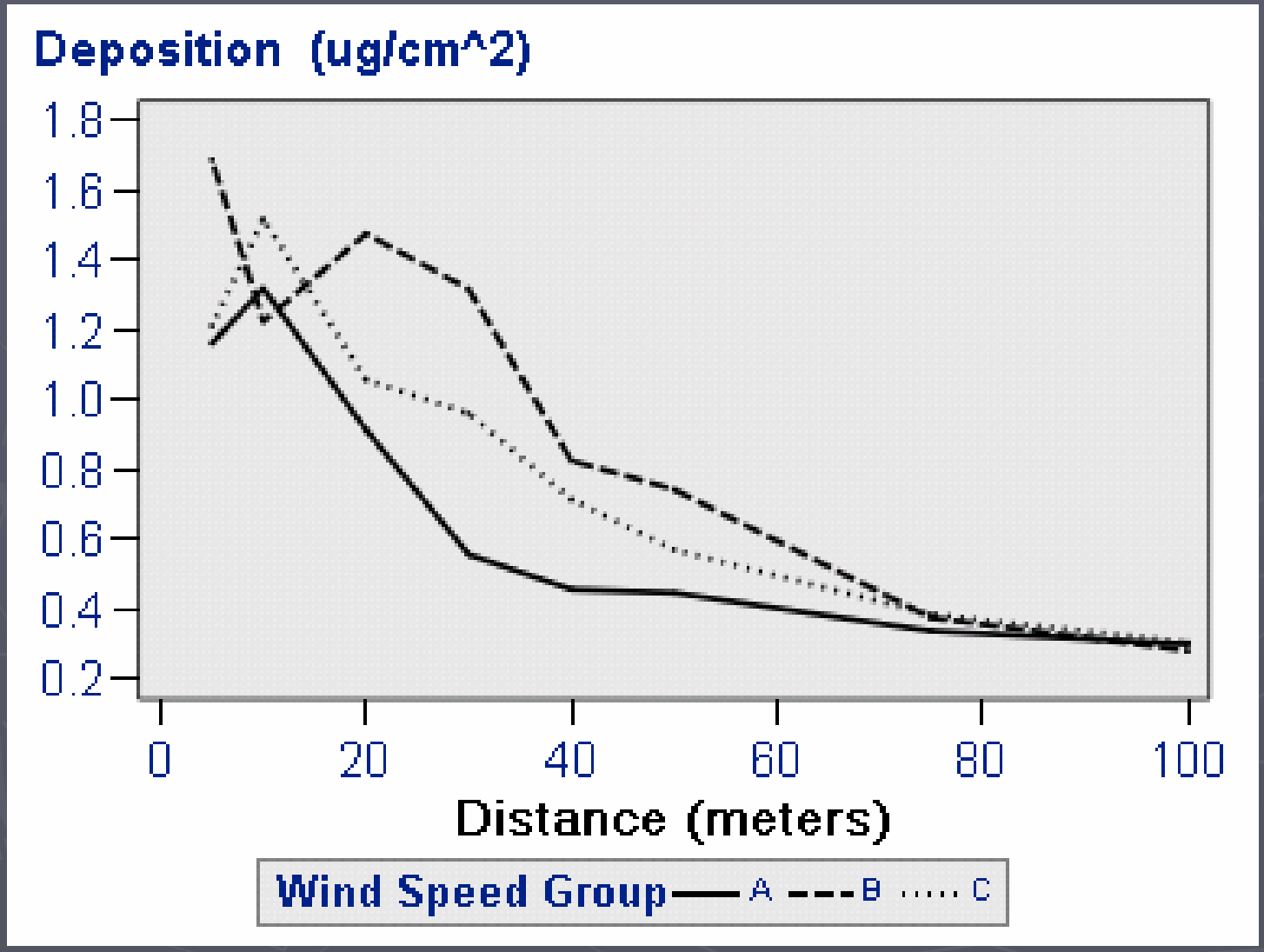
Results – Ground Deposition (Mylar)



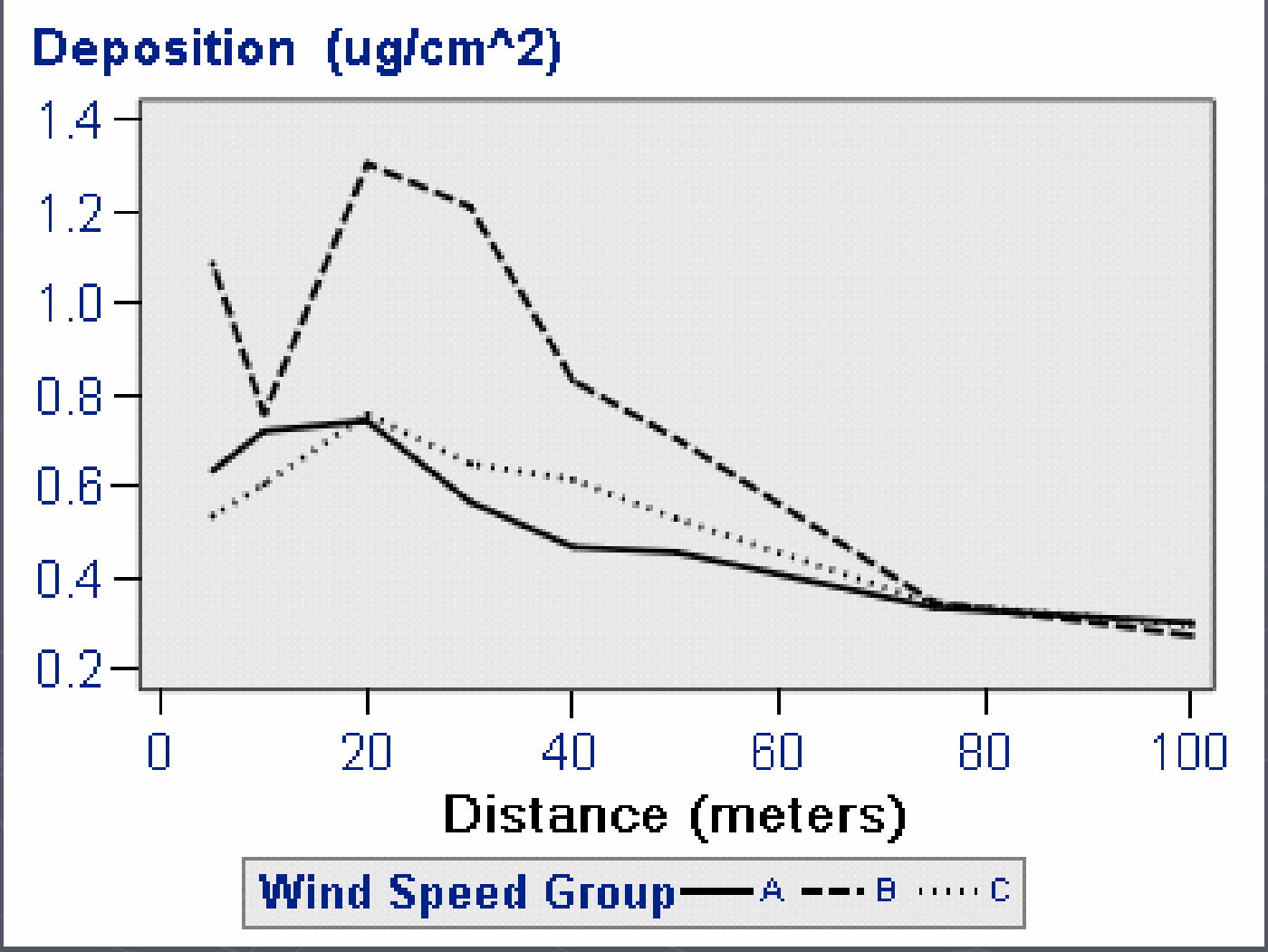
Results – Airborne Deposition (Screen)
5 ft



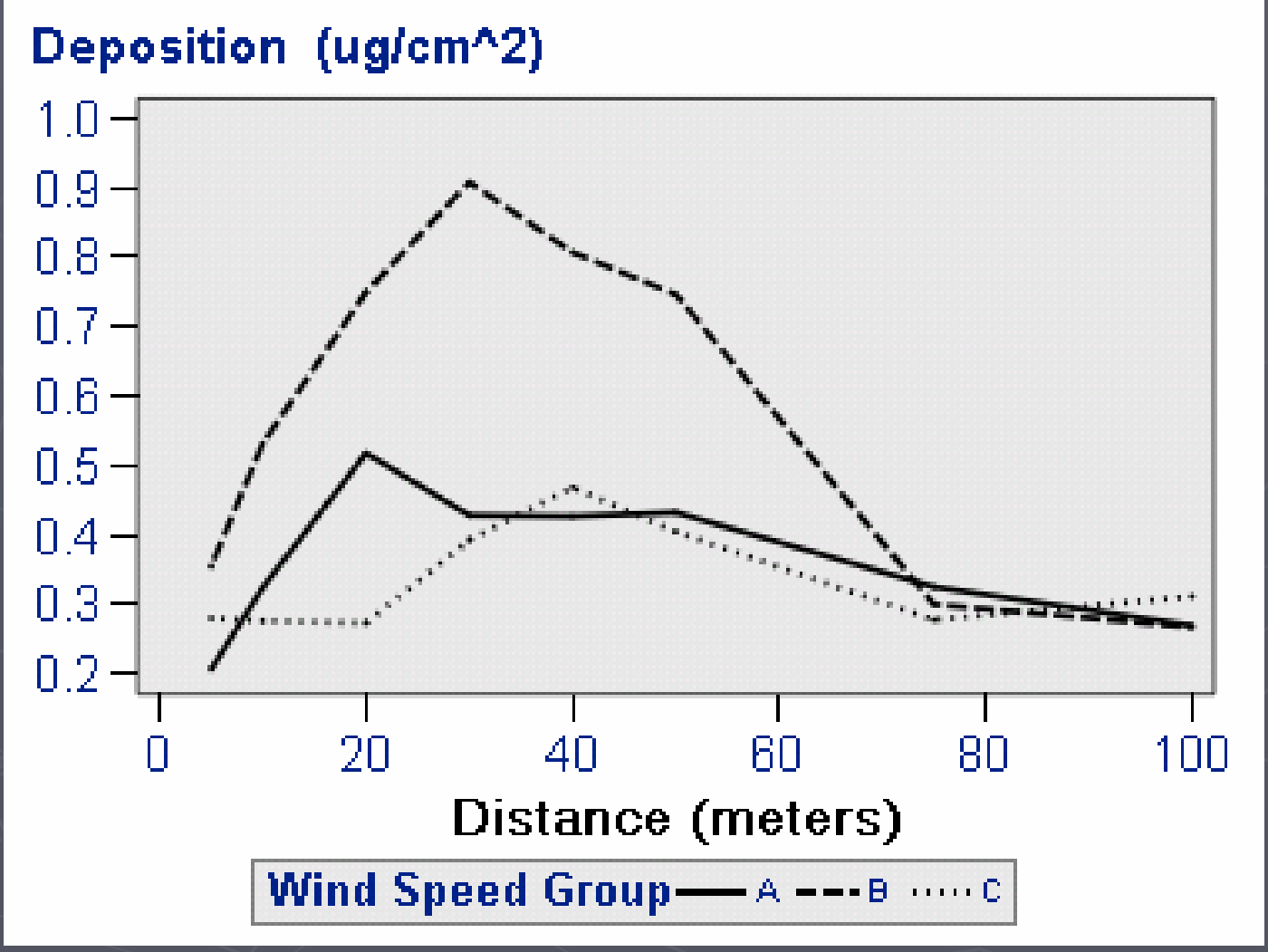
Results – Airborne Deposition (Screen) 10 ft



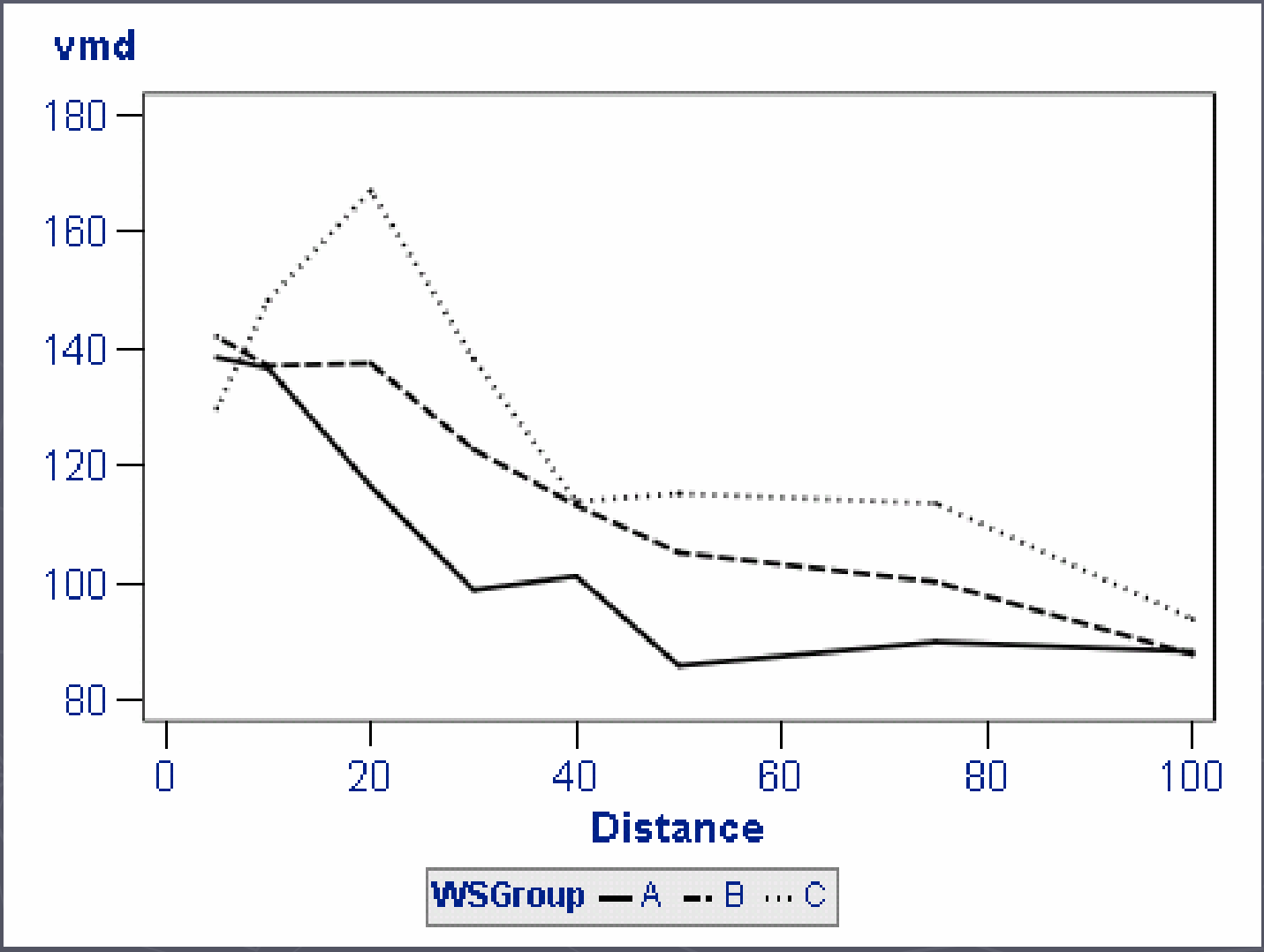
Results – Airborne Deposition (Screen) 15 ft



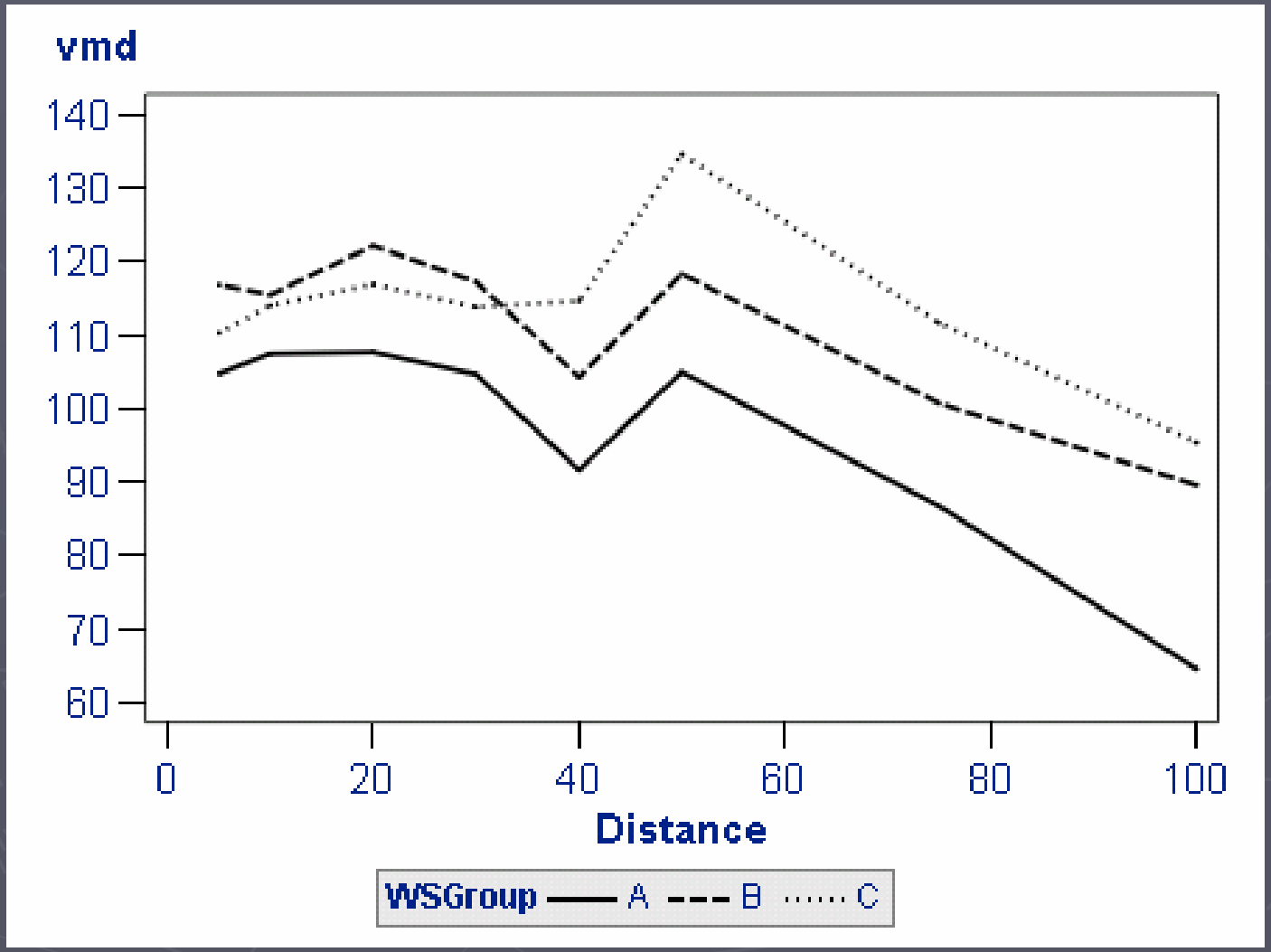
Results – Airborne Deposition (Screen) 20 ft



Results – Droplet Size (WSP)
10 ft



Results – Droplet Size (WSP)
20 ft



Conclusions

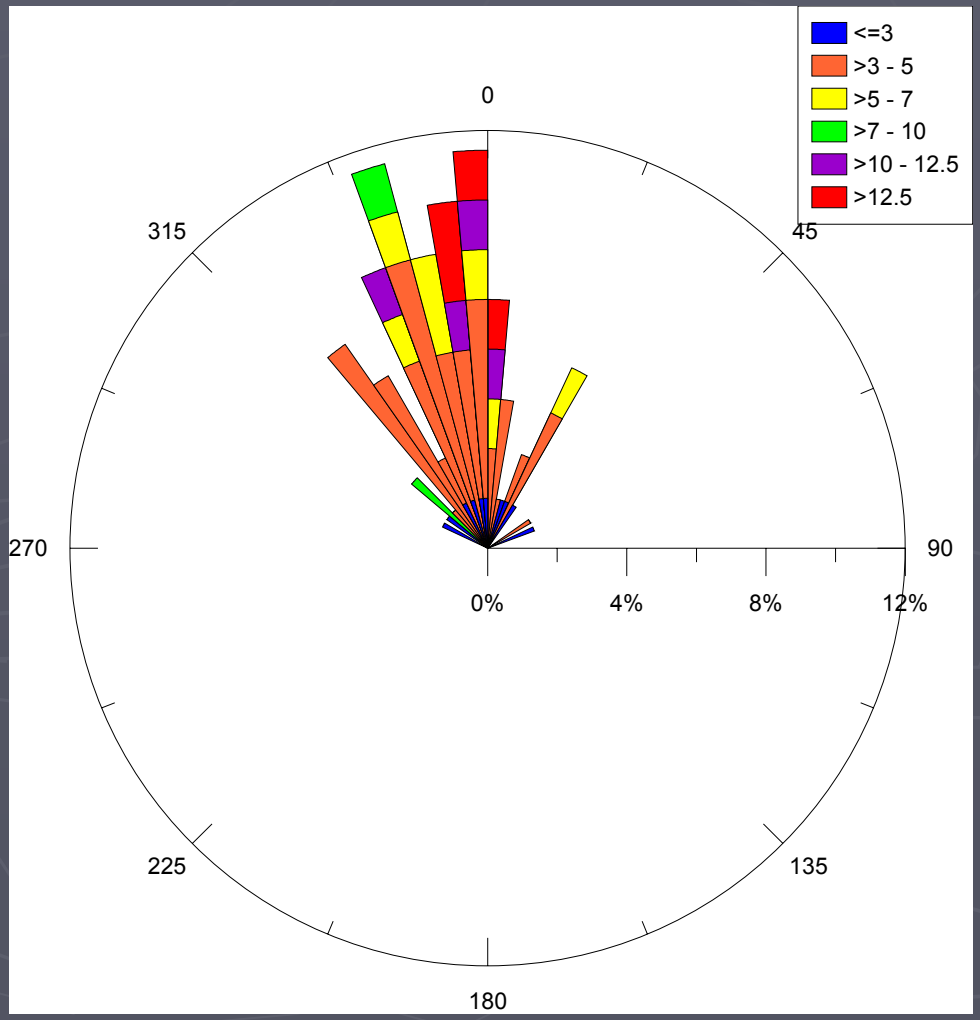
- Increased downwind deposition with increased wind speed (as is expected)
- Larger droplets travel further downwind and higher up at increased wind speeds (also expected)
- Indication of increased airborne concentrations further downwind for reps with Group B wind speeds.
  - Possible cause
    - Reps in Group B tended to be latest in the day (exception Day 1 Reps 1 and 3) and therefore potentially during greater periods of stability.

Areas to be Addressed

- Sample site selection
  - Uniformity of surrounding areas
    - Prevent influence of differing surface characteristics from masking stability effects.
- Sampling screen protocol
  - Examine affects of wind direction on sampling efficiency
- Meteorological monitoring procedures
  - Temperature sounding measurements
  - Methodology for use of in-flight real-time instrumentation for measurements
    - AIMMS

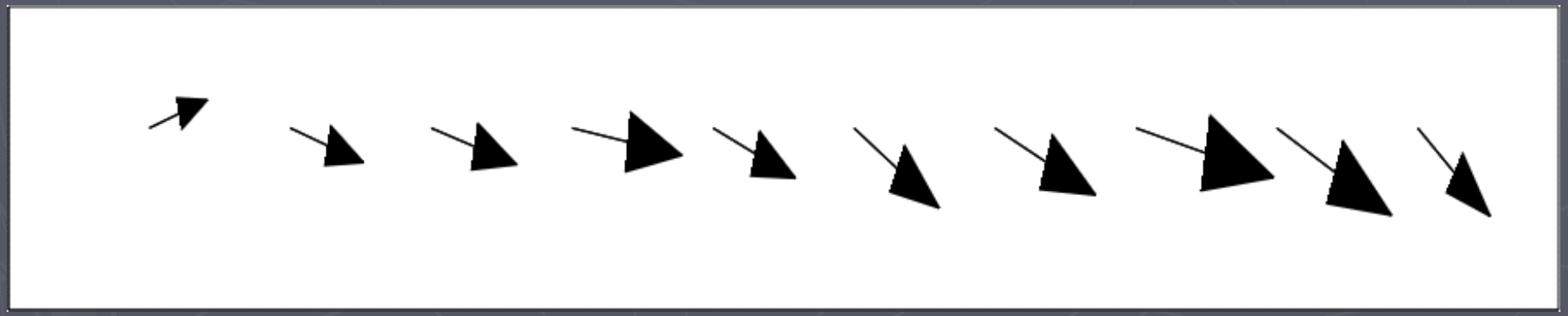
In-Flight Real-Time Meteorological Measurement

- Allows for recording of met. data during application.
  - Example
    - Windrose of met data that occurred during Day 1 replications



In-Flight Real-Time Meteorological Measurement

- Variation of wind speed and direction along a flight line
  - Data taken in 1 second intervals
    - 220 feet between readings



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